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An Analysis of the Social and Political Barriers to Wind Energy Development in Lancaster County, Nebraska

Corrin Bemis
University of Nebraska-Lincoln

AN ANALYSIS OF THE SOCIAL AND POLITICAL BARRIERS TO WIND ENERGY DEVELOPMENT IN LANCASTER COUNTY, NEBRASKA

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by
Corrin Bemis, BA
Environmental Studies and Economics
College of Arts and Sciences

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Faculty Mentors:
Martha Shulski, PhD, Applied Climate and Spatial Science
Christine Haney, PhD, Environmental Studies

Abstract

With the increasing threat of climate change beginning to impact cities and regions in the United States, many states are turning to renewable energy sources as a way to mitigate their carbon footprint. While Nebraska has the potential to be a leader in wind energy development within the next few years, some restrictions are still put in place that slow down the expansion of wind farms. Although the state is ranked 4th in the nation for wind energy potential, Nebraska is ranked 20th for actual wind energy development. This paper will define the social and political barriers that stand in the way of wind energy development in Lancaster County, Nebraska. The system of wind energy in the county will be defined using the *Social Fabric Matrix* outlined in Gregory Hayden's *Policy Making for a Good Society*. Following this research, a policy proposal to increase the amount of wind energy development in the state will be presented using Elinor Ostrom's *Social-Ecological Systems Framework*.

Introduction

As the effects become increasingly real and apparent, more of the United States population is considering the idea of climate change to be a meaningful threat to our national security and wellbeing. Disappearing glaciers, rising sea levels, biodiversity loss, and changes in precipitation patterns are just some of the concerns that are starting to convince the general public that action needs to be taken to mitigate the effects of a changing global climate. One of the first places many people look when thinking about this overwhelming issue is renewable energy. One renewable energy source that has gotten a lot of attention in the Midwest is wind energy.

According to the University of Nebraska - Lincoln's Wind Energy and Wildlife Project, Nebraska is currently ranked 4th in the United States for wind potential (UNL 2016). Contrastingly, we are ranked 20th for actual wind energy development. This is a pretty large disparity. Although Nebraska has the potential to produce 880,000 megawatts of wind energy, the Nebraska Renewable Energy Laboratory (NREL) cites that we are currently only producing 926 megawatts (Nebraska 2014). This contributes to Nebraska's very large opportunity to develop wind farms within the state. Although Lancaster County is no different, in 2015, the Lancaster County Board voted 3 – 2 for more restrictive regulations on wind turbine noise levels (Griffin 2015). These new regulations stalled major wind development projects and made it nearly impossible for private companies to develop new wind energy in the county.

The development of wind energy in Lancaster County is important because our current energy consumption portfolio poses risks to the habitats and ecosystem of Nebraska. According to the Official Nebraska Government website, only about 17% of energy consumed in the state is from renewable sources. The rest of it is from sources like coal, natural gas, and petroleum.

Besides releasing large amounts of carbon dioxide into the air when produced, these energy sources threaten the habitats and ecosystems of Nebraska. The social and political barriers to wind energy development need to be studied in order to find viable methods to increase the amount of renewable energy in Lancaster County.

The majority of my research will be focused on the barriers that have hindered the development of wind energy in Lancaster County and whether the county should increase this development in the future. To start my research I will look into the 2015 decision made by Lancaster County Health Department to increase restrictions on wind energy. This decision was made after the Lincoln Lancaster County Health Department released a statement saying wind turbines produce enough noise to be a health hazard for residents if the turbines are louder than 40 decibels from any residential or commercial structure (Hammel, 2015). According to the Hearing Health Foundation, this is the amount of noise that is generated from a refrigerator, a common household appliance. Because of this statement, and complaints from some farmers in the county over land rights, the Lancaster County Board voted in 2015 to increase the restrictions from 50 decibels, a common restriction adopted by counties, to 40 decibels (Text Amendment, 2015). This change pushed wind developers away from Lancaster County and has the potential to keep wind energy companies out of the entire state of Nebraska.

Research Questions and Hypothesis

My research questions are as follows: What are the institutions that are currently hindering the development of wind energy in Lancaster County, Nebraska? What social beliefs, attitudes, or values have led to a lack of renewable wind energy in Lancaster County? Is it

politically and economically viable for the county to increase its dependency on wind energy despite these institutions?

My hypothesis is as follows: A number of institutions have acted as barriers to the development of wind energy including, but not limited to, the Lancaster County Board, the Lincoln-Lancaster County Health Department, the Oil and Coal Industries in Nebraska, and citizens of Lancaster County. There are a variety of social beliefs that have hindered the development of wind energy including public health, economic viability, and reliable energy production. Despite these institutions and social beliefs, it is economically and politically viable for Lancaster County to develop more wind energy.

Methods and Materials

I will begin research by completing a descriptive study/meta-analysis of the social institutions that have negatively affected the development of wind energy in the county. The Lancaster County Board, the Lower Platte South (LPS) Natural Resource District (NRD), the Lincoln-Lancaster County Health Department, the Nebraska legislature, the courts/legal system, wind energy developers, the Lancaster County Board, county citizens, and the oil/coal industry will be analyzed in regards to their relationship as institutions with the development of wind energy in the county. I will analyze the roles of each institution using the Social Fabric Matrix (SFM), laid out in Gregory Hayden's *Policy Making for Good Society*. I will then discuss the policies, laws, and social beliefs that have hindered development.

The SFM matrix is a tool that allows researchers and policy makers to define the relationships within a real-world system. These relationships are expressed as deliveries with one social, technological, or ecological institution delivering criteria to other social, technological, or

ecological institutions. Its purpose is to define the system in parts and as a whole in order to define a problem or system as completely and accurately as possible (Hayden, 2006, p.5).

The SFM expresses the SFM network using rows and columns to dictate deliveries and relationships between the social, technological, or ecological institutions at play in the system being defined. At the intersection of the rows and columns, relationships are expressed using a "1". This indicates a delivery of criteria between two social, technological, or ecological institutions. The delivering components are noted in the rows on the left side of the matrix, and the receiving components are noted in the columns on the right side of the matrix. Cells where a delivery of criteria is not possible between two components is blocked out using a grey color. The SFM diagraph is used to express these deliveries in a visual way. I have included the SFM and SFM diagraph I used to analyze the barriers to wind energy in Lancaster County as Figures 1 and 2 in Appendix A.

Following the literature review, I will complete research on the regulations regarding wind turbines present in various counties throughout the state of Nebraska.. In order to complete this portion of the research, I will find the zoning plans and regulations of each county in Nebraska and put together tables depicting the noise level regulations on commercial sized wind turbines in each county. A map illustrating the noise level regulations in each county will then be created using the ArcGIS program.

Finally I will look more into the literature to find whether and increased shift to renewable energy is viable for the state of Nebraska and specifically Lancaster County. I will look into the potential for wind energy Lancaster County has, the current amount of our energy that is generated by renewables, and whether it is economically viable to increase this number.

With this information, I will draft a policy proposal based on my findings using on Elinor Ostrom's *Social-Ecological Systems (SES) framework*.

Ostrom's political framework attempts to identify what causes certain social-ecological systems to be successful while others fail. The theory identifies and analyzes the "relationships among multiple levels of these complex systems at different spatial and temporal scales" (Ostrom, 2009). I will use the framework to analyze the social and political climate in Lancaster County that has produced identifiable barriers to wind energy development. I will then use the framework to propose a policy for Lancaster County that will sustain the wind energy industry while considering the culture and beliefs in the county.

Literature Review

There is a wide consensus among the academic community that wind energy is beneficial in the fight against climate change and resource depletion because it provides a completely renewable way to harvest wind power for our energy needs. Researchers such as Siler-Evans (2013), Kellett (1990), and Cullen (2013) have tested the results and came to the conclusion that the benefits of a completely renewable energy source currently outweigh wind energy's negative consequences. The positive research conclusions on this topic can be well summarized in this passage from the American Wind Energy Association (AWEA):

> In addition to reducing greenhouse gas emissions, wind energy also greatly reduces a variety of health-harming air pollutants, including smog-forming sulfur dioxide and nitrogen oxides, dangerous particulate matter, mercury, and other toxins. Wind energy also reduces the massive quantity of water that is evaporated during the cooling process at conventional power plants. In 2013, wind energy saved 36.5 billion gallons of water, or 276 billion bottles of water. At the

> end of 2013, there were over 12,000 megawatts (MW) of wind energy under construction, which will eventually help to make an even bigger dent in emissions. On average, wind generation will avoid roughly 0.6 metric ton (1,300 pounds) or CO2 for every megawatt hour (MWh) of wind generation. When all 12,000 MW have completed construction, operational wind projects in the U.S. will reduce power section emission by a total of 117 million tons annually, or over 5.3% of power sector emissions (American, 2014).

The American Wind Energy Association puts together annual reports that demonstrate the marketability and effectiveness of wind energy every year. Since the AWEA began releasing these reports, the costs of wind energy have continuously decreased while the productiveness of each wind turbine has increased. Currently across the country, on average, 3.15 pounds of SO2, 1.05 pounds of N2O, and 0.71 tons of CO2 are avoided per MWh of wind energy (Cullen, 2011). Similarly, "The US Department of Energy estimates that achieving 20% wind penetration in the United States would reduce CO_2 emissions by 825 million metric tons by 2030." (Siler-Evans, 2013, p11768). These numbers have been increasing steadily since the early part of the 21st century. "Wind energy is the most important energy source in the developing renewable infrastructure. It became the primary source of new U.S. energy in 2012, then producing 43 percent of new generating capacity. Wind energy produces no carbon pollution during operation, and, in the nation's windiest corridors, is limited only by transmission and storage." (Badichek, 2015, p7)

While the research mentioned above demonstrates the increasing reliability and environmental benefits of wind energy across the country, it is important to acknowledge some of the consequences of wind energy development. While much of the community agrees that the benefits of wind energy outweigh the costs, there are still many groups and papers who argue

against this notion. Many of the researchers who argue against wind energy development cite migrating bird habitats as the base of their argument (Badichek 2015, Kunz 2007, Leddy 1999). According to the University of Nebraska's Wind Energy and Wildlife Project, there is about 2.19 birds per turbine per year that are killed by coming into direct contact with wind turbines. For bats the rate is much higher as 47.53 bats per turbine per year. The study also found that "between 2000-2011, about 975,000 bats were killed by wind turbines in the U.S. and Canada" (Potential Impacts, 2018). It is important to take the habitats of birds, bats, and other forms of wildlife into account when planning and developing wind farms.

Direct collisions are not the only threat wind turbines pose to native bird and bat populations in Nebraska. In the 1999 study, Leddy et al. found that bird populations do not respond well to the physical structure or noise created by wind turbines. The presence of wind turbines, decreases the breeding habitat available to native birds and bats by disturbing the species during their nesting seasons. For this reason, Leddy et al. recommend that "wind turbines be placed within cropland habitats that support lower densities of grassland passerines" (Leddy, 1999, p103). Like Leddy et al., many of the researchers worried about migrating bird habitats still advocate for responsible wind energy development. This view can be summarized in Gregg Badichek's article published in Consilience: The Journal of Sustainable Development. Here Badichek writes "climate change induced by the continuous burning of carbon-based fuels likely poses a greater threat to endangered species than does the growth of commercial-scale renewable energy sites" (Badichek, 2015, p1).

For the purposes of simplicity, let's assume that the benefits of wind energy currently outweigh the costs in 2018. With this assumption, we still have to ask the question of whether wind energy is economically and environmentally feasible for the United States and the state of

Nebraska in particular. In this category, the research is not as unified or consistent as with the benefits of wind energy.

First lets focus on the environmental feasibility of wind energy in the state of Nebraska. According to the Nebraska Wind Energy and Wildlife Project, Nebraska is ranked 4th in the United States for wind potential (UNL 2016). In order for wind energy to be cost effective and productive, the average wind speed of an area needs to be over 6.5 meters per second. One of the reasons why Nebraska is ranked 4th in the nation for wind energy potential is because over 80% of the state has an average annual wind speed of over 6.5 meters per second (UNL, 2016). According to Siler-Evans et al., "Wind turbines are most effective at displacing CO_2 emissions when located in the Midwest, where the wind resource is excellent and wind energy primarily displaces coal-fired generators" (Siler-Evans, 2013, p11768-69). The Midwestern United States offers the right amount wind power, sparsely dense land, and coal-based power plants to offset the costs of wind energy development (Nebraska, 2017, Carley, 2009, Amin, 2015). According to an article published in the *Proceedings of the National Academy of Sciences of the United States of America* "From an energy standpoint, wind turbines perform best in the Great Plain south through west Texas, where capacity factors can exceed 40%" (Siler-Evans, 2013, p11768). The state of Nebraska is an ideal example of a geographic location that fits all of the necessary criteria for efficient wind energy production.

Although Nebraska provides an ideal environment for wind energy development, the question still stands about whether it is economically viable for Nebraska to begin relying more heavily on wind power for its energy needs. While wind energy is more expensive than some of traditional energy sources initially, the cost is quickly covered due to the long life span of the individual windmills. According to the American Wind Energy Association, wind mills are

expected to last for 20 years or more without maintenance fees. Within this time, the price of the original wind mill and installation is more than covered in the money saved by using renewable wind energy (AWEA). Once the original set up cost of wind energy is out of the way, wind becomes one of the least expensive ways to generate electricity, outperforming coal, nuclear energy, and solar energy (Lazard, 2017). The two tables below detail the comparably inexpensive costs of wind energy compared to other energy sources.

Table 1

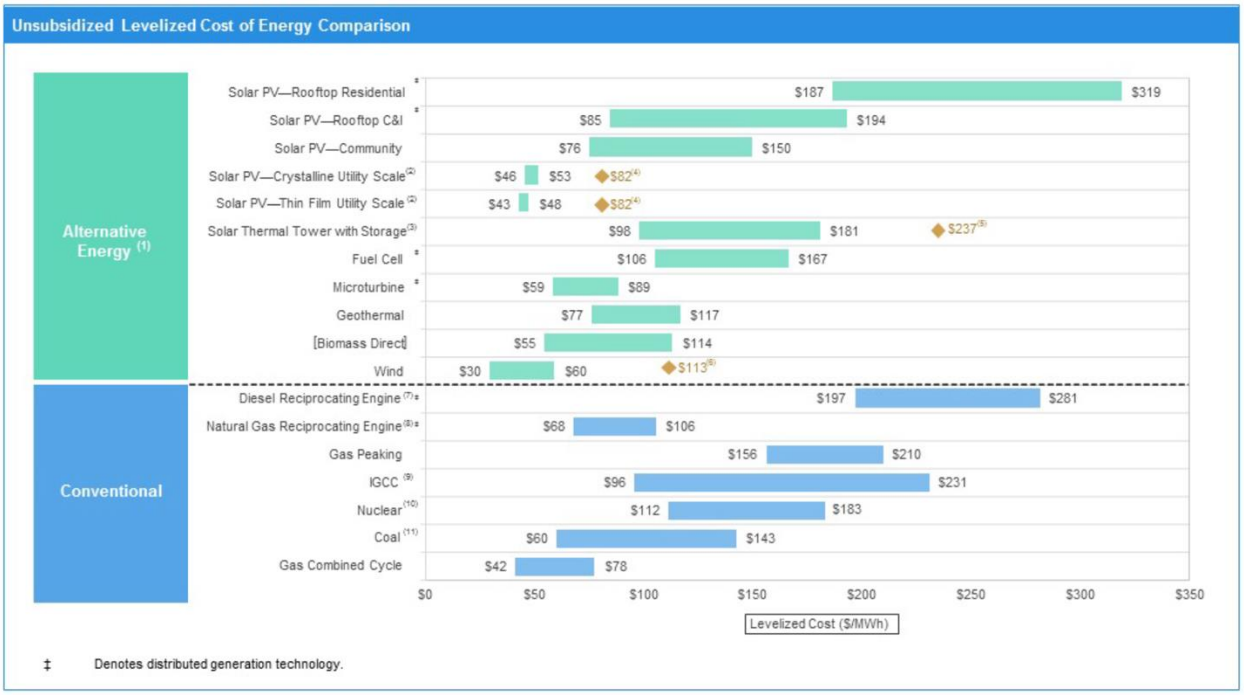
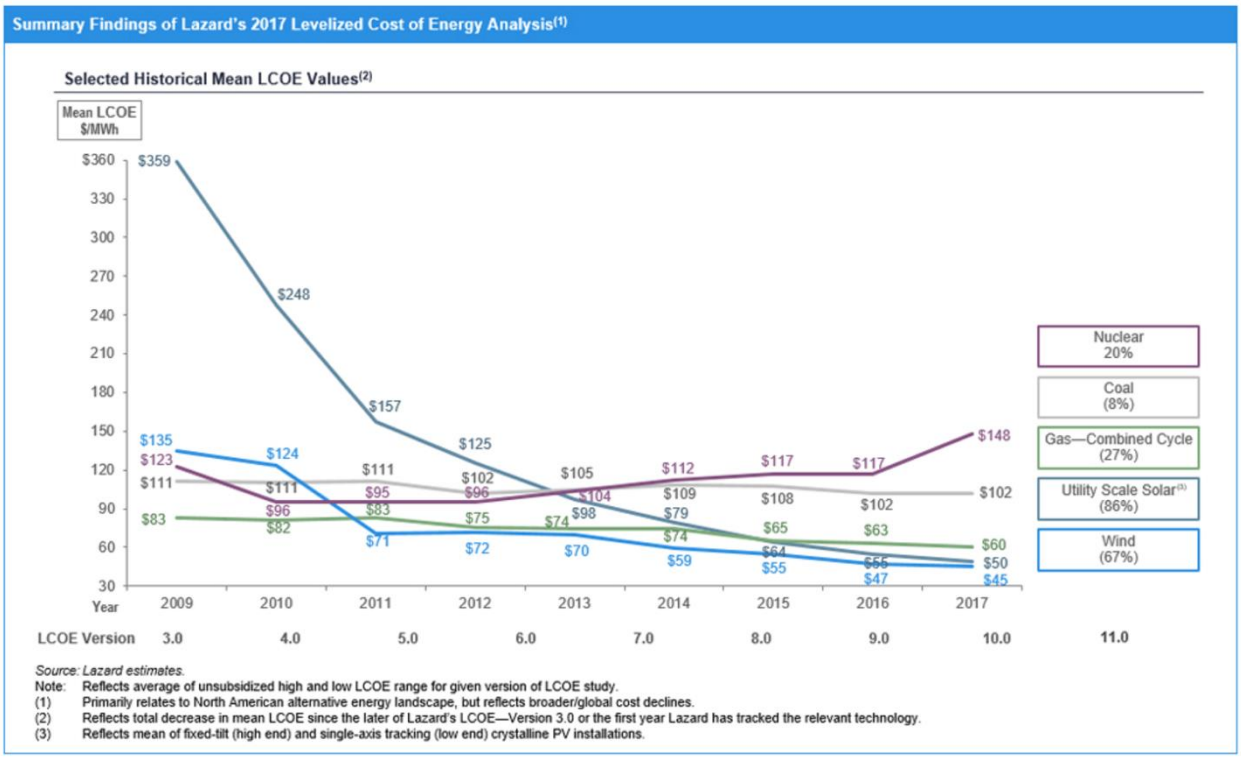


Table 2



Source: Lazard. (2017). *Lazard's Levelized Cost of Energy Analysis – Version 11.0*. Retrieved from https://www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf.

While solar energy has dropped in price the most rapidly since 2009, wind energy is still the least expensive energy source and the most efficient for the state of Nebraska (Wind Energy, 2017).

While research on the benefits, consequences, and feasibility of wind energy production is ample and far reaching, not much research exists to go beyond these simple questions. In the following sections, this paper will focus on analyzing the social and political barriers that have hindered the development of wind energy in Lancaster County, Nebraska despite the apparent benefits wind energy could bring for the state and county. Before narrowing the focus

specifically to wind energy, I will discuss the social and political barriers to climate change in Nebraska.

Identifying barriers to climate change mitigation is a necessary step in creating successful policy change in Nebraska as well as the entire United States. In their 2010 article, Susanne C. Moser and Julia A. Ekstrom identify three common areas where barriers tend to arise in the policy development process. During the first stage, the understanding phase, barriers such as receptivity to information, level of consensus, and threshold of concern exist. During the planning phase of policy development, barriers such as availability of data, level of agreement, and threshold of perceived option feasibility stand in the way of policy development and implementation. The last phase, the managing phase includes barriers such as clarity/specificity of option, willingness to learn, and availability and sustainability of economic resources (Moser, 2010).

In 2016, the Yale Program on Climate Change Communication released a set of Climate Opinion Maps that detailed Americans' beliefs on a variety of issues surrounding climate change broken down by county. The study measures questions such as the percentage of "adults who support regulating CO2 as a pollutant" or the percentage of "adults who think global warming with harm future generations" (Marlon, 2016). When the Yale study asked Nebraskan adults if they "are worried about global warming," 56% of Lancaster County residents responded affirmatively. (Marlon, 2016). While this number is higher than 50% and constitutes a majority, the relatively high number of citizens who are not worried about the impacts of climate change, specifically global warming, serve as an identifiable barrier to climate change policy. Taking a closer look at renewable energy, the following section will focus on identifying the social and

political barriers to wind energy development in Lancaster County, Nebraska using Gregory Hayden's *Social Fabric Matrix* and Elinor Ostrom's *Social-Ecological Systems Framework*.

Results

Social Fabric Matrix

The purpose of the next few pages is to define, describe, and explain the system that is delivering the barriers that have hindered the development of wind energy in the state of Nebraska. I will research the policies, laws, institutions, and social beliefs that led to the Lancaster County Board's decision to implement restrictions on wind energy production on the state. The articulation of the system will be completed with the use of the social fabric matrix (SFM) and digraph as it is outlined in F. Gregory Hayden's *Policy Making For a Good Society*. Every cell with a delivery indicated in the SFM will be defined, described and explained. Furthermore, social indicators (graphs and diagrams) will be presented in the appendix for some cells.

The definition, description and explanation of the SFM cell deliveries will be the major part of the paper. Because the same component may appear in the description of more than one cell, that component will be fully explained once when it first appears. When it is used again, the reader will be referred back to the cell where it was originally explained rather than to explain it again.

The cell deliveries are explained below:

<u>Social Beliefs delivering to the Lower Platte South Natural Resource District (4,11) (8,11) (9,11)</u>

There are a couple social beliefs that have contributed to this mission statement presented by the Nebraska's NRDs website. Cell (4,11) delivers criteria from the natural resource protection social belief to the Lower Platte South NRD (LPSNRD). The mission of the Natural Resource Districts (NRDs) in Nebraska is "to conserve, sustain, and improve [the state of Nebraska's] natural resources and environment" (Nebraska Association, 2017). Each NRD in Nebraska, including the LPSNRD hosts educational events and develops programs to further the survival of Nebraska's natural resources. Cell (9,11) delivers criteria from the renewable energy social belief to the LPSNRD. This NRD recently launched a program "to identify sources of nonpoint source pollution, issues of ground water and surface water quality, quantify and characterize them, and identify solutions" (Projects Completed, 2017). Renewable energy is delivering criteria to the LPSNRD by being a viable solution to ground and surface water pollution.

Social Beliefs delivering to the Lincoln-Lancaster County Health Department (5,12) (10,12)

Cell (5,12) is the Public Health social belief delivering criteria to the Lincoln-Lancaster County Health Department (LLCHD). The mission statement of the LLCHD is "to protect and promote the public's health" (Health Department, 2017). Specifically, the mission statement of the Environmental Public Health Division of the LLCHD is "to protect human health by assuring healthy environments [and] safeguarding the natural environment upon which life depends" (Environmental Public Health, 2017). Cell (10,12) is the Noise Level social belief delivering criteria to the LLCHD. In 2015, the LLCHD wrote in a report to Lancaster County Officials that the noise generated by wind turbines can cause annoyance and pose a health risk to those nearby (Hammel, 2015). The Department suggested a limit noise limit for wind turbines of 40 decibels during the day and 37 at night. The previous restriction, and the restriction present in the

majority of counties in Nebraska, is 50 decibels (Hammel, 2015). The LLCHD wants to protect citizens from the annoyance wind turbine noise generates.

Social Beliefs delivering to the Nebraska Legislature (1,13) (6,13)

Cell (1,13) is the Economic Viability social belief delivering criteria to the Nebraska Legislature. Senators in the Nebraska Legislature strive to pass laws and regulations that will increase the economic vitality of the state of Nebraska. In 2017, LB392 was passed because "the Legislature finds and declares that wind energy production has a growing role in the economic vitality of rural areas of that state and in the state's overall economy" (Wind Friendly Counties Act, 2017). Cell (6,13) is the Energy Independence social belief delivering criteria to the Nebraska Legislature. In 2016 legislation session, a resolution was introduced to create a committee that would examine "how the Renewable Fuel Standard program, authorized under the federal Energy Policy Act of 2005 and expanded under the federal Energy Independence and Security Act of 2007" affected the state of Nebraska (Fuel Blending, 2016). This resolution is an example of Energy Independence delivering criteria to the Nebraska Legislature.

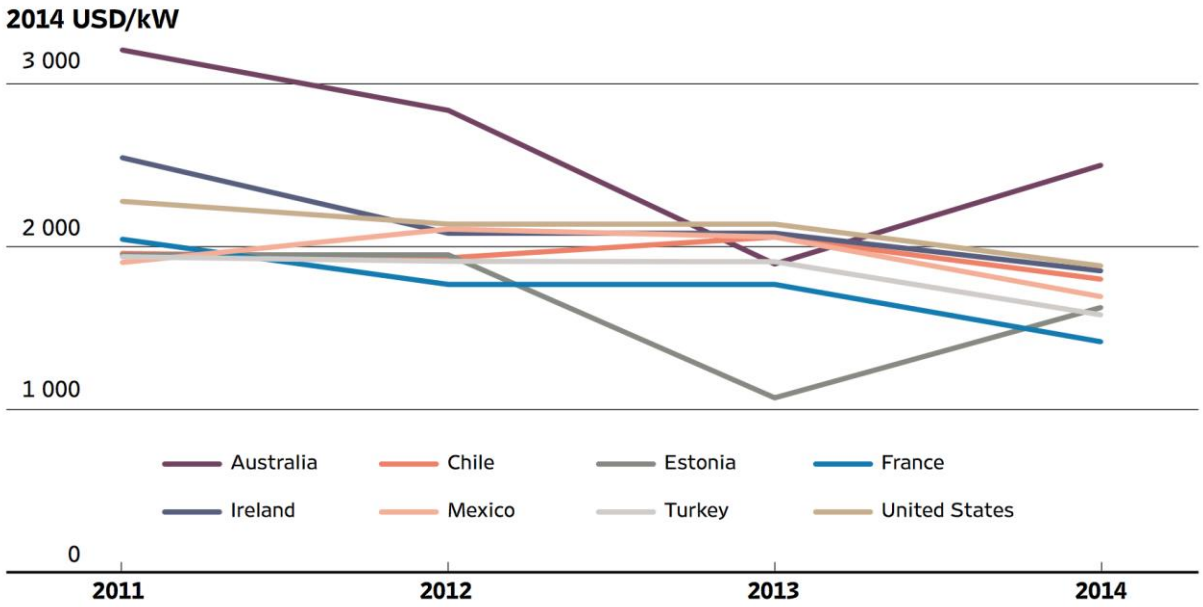
Property Rights delivering to the Courts/Legal System (3,14)

Cell (3,14) is the Property Rights social belief delivering laws and regulations to the Courts and Legal System of Lancaster County. When deciding on the outcome of a case, the courts take pre-existing laws and court decisions into consideration. The 1973 case *Deans v. West* illustrated the importance of an adequate zoning map in the state of Nebraska. The court stated the importance of "an official zoning map to provide sufficient information to use when determining whether a piece of property is contained in a zoning jurisdiction" (*Deans,* 1973).

Social Beliefs delivering to the Engineers and Wind Farm Developers (1,15) (2,15) (9,15)

Cell (1,15) is the Economic Viability social belief delivering criteria to engineers and wind farm developers. Engineers who develop wind energy technology strive to bring down the cost in order for the energy source to be more attractive to states, counties, and power districts. Regulations against wind farms are likely to decrease as the cost of wind energy decreases (Gielen, 2012). The table below demonstrates the decrease in costs in wind energy since 2011.

Total Costs of Commissioned Large Wind Farms in Selected Countries from 2011 - 2014



Source: Amin, A. Z. (2015, Jan). Renewable Power Generation Costs in 2014 (Rep.). Retrieved from https://www.irena.org/documentdownloads/publications/irena_re_power_costs_2014_report.pdf.

Cell (2,15) is the Reliable Energy Production social belief delivering criteria to engineers and wind farm developers. Much like the economic viability social belief, criteria delivered by the

reliable energy social belief encourage engineers to produce more energy per wind mill. The more watts of energy that are produced per windmill, the more likely a state will adopt wind energy in order to meet their renewable portfolio standards. This point is outlined Sanya Carley's article published in the *Policy Studies Journal*. Cell (9,15) is the Renewable Energy social belief delivering to engineers and wind farm developers. Wind energy engineers work to improve existing wind turbine technology in order to increase the amount renewable energy used in their city, state, or country. Wind energy is a renewable resource that does not produce carbon dioxide or take from the Earth's natural resources (UNL, 2016).

Social Beliefs delivering to the Lancaster County Board (1,16) (3,16) (8,16)

Cells (1,16) and (8,16) are the Economic Viability and Land Use social beliefs delivering criteria to the Lancaster County Board. The primary responsibilities of the Board according to their website are "to care for the country property [and] to adopt the county budget" (Lancaster County, 2017). The Board is concerned with both the economic viability of the county and the use of the land in the county. This second relationship is seen again in cell (3,16), the delivery of criteria using zoning laws from the Property Rights social belief to the Lancaster County Board. In County Resolution R150061, passed by the Lancaster County Board in 2015, the Board made amendments to the 1979 Zoning Resolution of Lancaster County in order to increase the restrictions against wind energy development. To do this, the Board cited property rights of citizens in the county (Zoning Resolution, 2015).

Social Beliefs delivering to the Farmers and Lancaster County Citizens (3,17) (9,17)

Cell (3,17) is the Property Rights social belief delivering criteria to the farmers and citizens of Lancaster County. Many of the opponents of wind energy in Nebraska believe the wind farms go against their property rights. One resident who utilized this argument to win new restrictions on wind energy in Lancaster County is Cindy Chapman, the founder of Stop Hallem Wind. Chapman believes tougher restrictions would "protect property values and address health concerns" (Hammel, 2015). Cell (9,17) is the Renewable Energy social belief delivering criteria to the citizens of Lancaster County. In an article published in the Omaha World Herald, John Atkinson of Lincoln states that "It's in the public interest to move to clean, renewable power" (Hammel, 2015). In relationship is also illustrated by the number of citizen led organization in the county that are devoted to bringing renewable energy to Lancaster County. A couple of these organizations are the Nebraska League of Conservation Voters, The Sierra Club, and Bold Nebraska.

Social Beliefs delivering to the Oil and Coal Industries (1,18) (2,18)

Cell (1,18) is the Economic Viability social belief delivering criteria to the oil and coal industries. Individual businesses in the oil and coal industries are concerned with making a profit. The more economically viable the production of natural gas, petroleum, and coal for consumer consumption, the more these products will be developed in Lancaster County. The table below provides information about the cost of natural gas, petroleum, and coal.

	Coal		**Petroleum/Natural Gas**	
Year	**Average Cost (Dollars per MMBtu)**	**Average Cost (Dollars per Ton)**	**Average Cost (Dollars per MMBtu)**	**Average Cost (Dollars per Ton)**
2010	2.27	44.64	14.02	84.80
2011	2.39	46.65	19.94	119.54
2012	2.38	46.09	21.85	131.28

2013	2.34	45.33	20.56	124.90
2014	2.37	45.98	19.87	120.26
2015	2.22	42.86	11.49	69.79
2016	2.11	40.64	9.40	56.95

Source: U.S. Energy Information Administration. (2017) *Electric Power Monthly*. "Table 4.1 Receipts, Average Cost, and Quality of Fossil Fuels." Retrieved from https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_4_01.

Cell (2,18) is the Reliable Energy Production social belief delivering to the oil and coal industries. Similar to the wind energy developers, the coal and oil companies want to produce energy that is reliable for the citizens of Lancaster County. This social belief encourages the petroleum, natural gas, and coal companies to produce energy at a steady, reliable rate. According to the Nebraska Power Association, "coal-fired power plants are built to run 24-hours a day, 7-days a week" (Nebraska Power, 2017).

The Lower Platte South NRD delivering to Social Beliefs (11,4) (11,8)

Cell (11,4) is the LPSNRD delivering criteria to the Natural Resource Protection social belief. The education programs hosted by the LPSNRD, like their Wild Nebraska program and their annual family nature nights encourages Lancaster County citizens to protect their natural resources. Cell (11,8) is the LPSNRD delivering conservation criteria to the land use social belief. The LPSNRD provides conservation easements to "landowners wishing to preserve unique natural resources forever (such as wetlands, forestland, native prairie, etc)" (Environmental Education, 2017). This program delivers criteria that encourages land owners to use their land to conserve Nebraska's natural resources.

The Lincoln-Lancaster County Health Department delivering to Public Health (12,5)

Cell (12,5) is the LLCHD delivering criteria to the Public Health social belief. By working "to protect and promote the public's health" (Health Department, 2017), Health Department employees deliver information to the public about practices that "[assure] healthy environments" (Environmental Public Health, 2017). This is done using educational materials and programs aimed at the citizens of Lancaster County.

The Nebraska Legislature delivering to Property Rights (13,3)

Cell (13,3) is the Nebraska Legislature delivering criteria to the Property Rights social belief through laws and regulations. Zoning laws are used to state what can be built on a piece of public land throughout the state of Nebraska and in Lancaster County (Zoning Regulations, 1997). The rights of private property and handled by the courts and legal system of Nebraska.

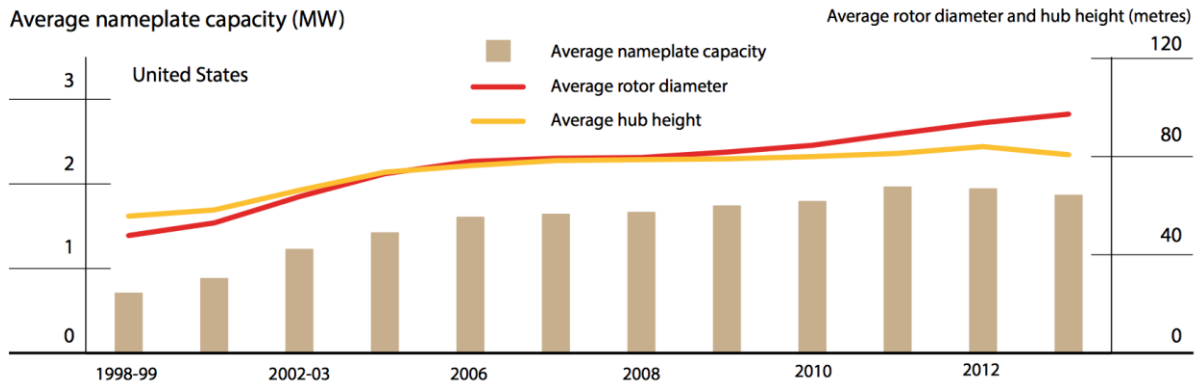
The Courts/Legal System delivering to Property Rights (14,3)

Cell (14,3) is the courts and legal system of Lancaster County delivering information to Property Rights through the use of laws and regulations. The 1973 case *Deans v. West* mentioned above illustrated the importance of an adequate zoning map in the state of Nebraska. Here the court delivered information to the zoning map of Nebraska in order to "provide sufficient information to use when determining whether a piece of property is contained in a zoning jurisdiction" (*Deans*, 1973).

Engineers and Wind Energy Developers delivering to Social Beliefs (15,2) (15,6)

Cells (15,2) and (15,6) are the engineers and developers of wind energy delivering information to the reliable energy production social belief and the energy independence social belief. As the reliability of wind energy increases and the amount of energy each turbine can produce increases, the idea that renewable energy could be a reliable way for Nebraska to become energy independent gets more popular. The graph below demonstrates the advances in wind energy technology since 1998.

Average Turbine Nameplate Capacity, Rotor Diameter and Hub Height from 1198 - 2012



Source: Amin, A. Z. (2015, Jan). Renewable Power Generation Costs in 2014 (Rep.). Retrieved from https://www.irena.org/documentdownloads/publications/irena_re_power_costs_2014_report.pdf.

Lancaster County Board delivering to Property Rights (16,3)

Cell (16,3) is the Lancaster County Board delivering zoning laws as information to the Property Rights social belief. As mentioned above, in County Resolution R150061, passed by the Lancaster County Board in 2015, the Board made amendments to the 1979 Zoning Resolution of Lancaster County in order to increase the restrictions against wind energy development. This is

an example of the Lancaster County Board delivering information to the property rights social belief through the use of resolutions and amendments (Zoning Resolution, 2015).

Farmers and Lancaster County Citizens delivering to Destruction of View (17,7)

Cell (7,17) is the Lancaster County citizens delivering information to the Destruction of View social belief. Some opponents of wind energy in Lancaster County argue that wind farms are an obstruction of the view of the natural landscape of Nebraska. This is cited on Cindy Chapman's website Prairie Wind Watchers, formally Stop Hallam Wind. On the home page, Chapman writes that the goal of the organization is "to protect our families and preserve the beauty of this great state" (Prairie Wind, 2015). Throughout this webpage, Chapman makes it clear that her organization wants to protect the views of the prairie landscape from wind farm development.

The Lincoln-Lancaster County Health Department delivering to Social Institutions (12,16) (12,17)

Cell (12,16) is the LLCHD delivering noise level regulation recommendations to the Lancaster County Board. As mentioned above, in 2015, the LLCHD sent a report to the Lancaster County Board recommending that the noise level restriction of wind turbines be changed from 50 decibels during the day and 42 at night to 40 decibels during the day and 37 at night (Hammel, 2017). The Department reported that wind turbine noise could be considered a public health risk if loud enough. Cell (12,17) is the LLCHD delivering programs and educational services to the Citizens of Lancaster County. The employees of the LLCHD work "to protect human health by assuring healthy environments [and] safeguarding the natural environment upon which life depends" (City of Lincoln, 2017). In an article in the Omaha World Herald, Scott Holmes, the

Environmental Public Health Manager at the LLCHD, is quoted saying "the annoyance [of wind turbines] can cause physiological reactions, including loss of sleep, increased heart rates and blood pressure" (Bergin, 2015). Here the LLCHD delivered protection from the annoyance caused by wind turbines to the citizens of Lancaster County by proposed stricter regulations on the noise levels of the turbines.

The Nebraska Legislature delivering to Farmers and County Citizens (13,17)

Cell (13,17) is the Nebraska Legislature delivering criteria to the farmers and citizens of Lancaster County in the form of laws and regulations. Each bill passed by the Nebraska Legislature turns into criteria that is delivered to the people of Lancaster County. A couple of the important bills with regards to wind energy development that have been mentioned are LB140: *Zoning Regulations, Ordinances, and Plan*, LB392: The *Wind Friendly Counties Act, and* LB406: The *Fuel Blending Resolution* (Zoning, 1997; Wind Friendly, 2017; Fuel Blending, 2016).

The Courts/Legal System delivering to the Nebraska Legislature (14,13)

Cell (14,13) is the courts and legal system delivering to the Nebraska Legislature. The criteria that the courts deliver to the Nebraska Legislature is in the form of judicial review. Once a bill is passed by the senators in the unicameral, it goes to the judiciary branch to be interpreted and applied (NCSL, 2017). For example, every time a new Zoning Bill is introduced and passed in the unicameral, like the 1997 *Zoning Regulations, Ordinances, and Plans* Act, it then goes to the courts for review and interpretation. This can be seen in the 1990 case *Whitehead Oil Co. v. City of Lincoln*. In this case, the courts interpreted the zoning regulations passed by the Nebraska

Legislature and decided residential land in neighborhood associations could not be used for commercial development, even in special circumstances (Whitehead, 1990).

Lancaster County Board delivering to Social Institutions (16,15) (16,18)

Cell (16,15) is the Lancaster County Board delivering criteria to the wind energy developers of the county. In an article published in the Omaha World Herald, Paul Hammel wrote, "In a vote that could affect wind farm development elsewhere in Nebraska, the Lancaster County Board on Tuesday adopted tough new noise restrictions on wind turbines" (Hammel, 2015). The criteria that the Board is delivering to the wind developers of the county is in the form of this restriction. Cell (16, 17) is the Lancaster County Board delivering criteria to the citizens of Lancaster County. This is done through the use of country resolutions. One of these was the *Text Amendment to the Lancaster County Zoning Resolution* which updated the zoning laws in order to take into consideration these new restrictions.

Farmers and Lancaster County Citizens delivering to Social Institutions (17,13) (17,16)

Cells (17,13) and (17,16) are the Farmers and citizens of Lancaster County delivering criteria to the Nebraska Legislature and the Lancaster County Board through voting. The citizens of Lancaster County are able to deliver criteria to and influence the Nebraska Legislature and the Lancaster County Board by voting for senators/board members and public amendments.

The Lower Platte South NRD delivering to Land (11,15)

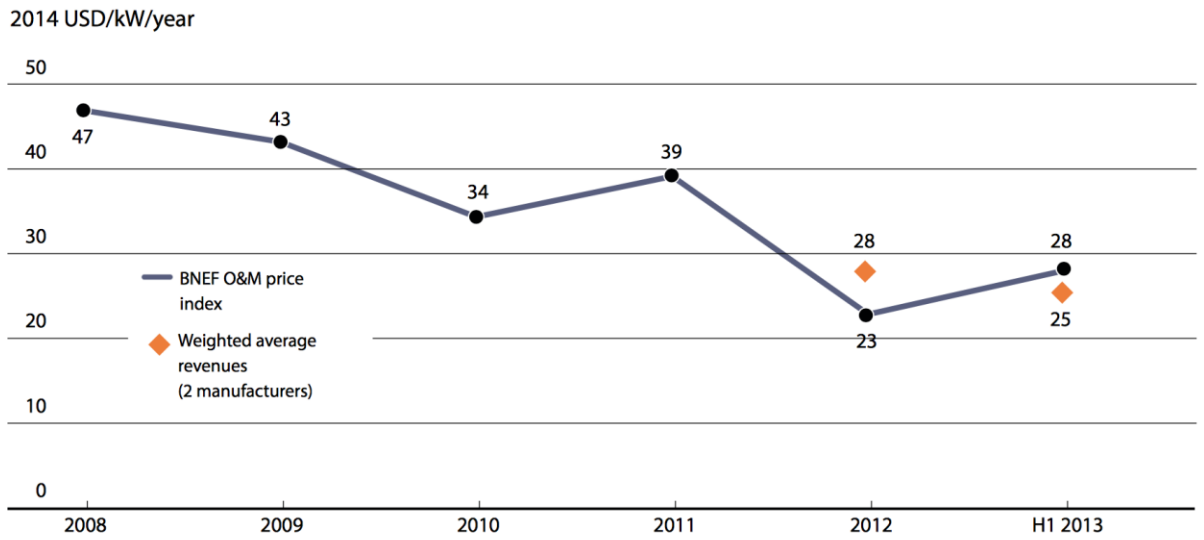
Cell (11,15) is the LPSNRD delivering criteria to land in Lancaster County. As mentioned above, the mission of the Natural Resource Districts (NRDs) in Nebraska is "to conserve,

sustain, and improve [the state of Nebraska's] natural resources and environment" (Nebraska Association, 2017). This objective allows the LPSNRD to deliver protection to the land in Lancaster County through a variety of programs.

Engineers and Wind Energy Developers delivering to Technology and Ecology (15,19) (15,20) (15,21) (15,22) (15,23) (15,26) (15,27)

Cells (15,19) (15,20) (15,21) (15,22) and (15,23) are the wind energy developers delivering tools, skills, and knowledge to the infrastructure, maintenance costs, transportation costs, wind turbines, and energy storage capabilities of wind energy. Engineers makes these deliveries by developing new technology that increases the power and capabilities of the wind turbines. The graph below shows the improvements in wind technology maintenance costs made by engineers over the past 15 years.

Full Service Operational and Maintenance Costs of Wind Turbines from 2008 - 2013



Source: Amin, A. Z. (2015, Jan). Renewable Power Generation Costs in 2014 (Rep.). Retrieved

fromhttps://www.irena.org/documentdownloads/publications/irena_re_power_costs_2014_report.pdf.

Cells (15,26) and (15,27) are the wind energy developers delivering to the migrating bird habitats and habitat destruction in Lancaster County. Results from various studies have shown that wind turbines can negatively affect various species of bird and their habitats. The Nebraska Wind Energy and Wildlife Project found that "potential impacts to wildlife and the environment from wind energy development can be through direct impacts on individual animals and through indirect impacts that cause loss or degradation of habitat" (Nebraska Wind, 2017).

The Oil and Coal Industries delivering to Habitat Destruction (18,27)

Cell (18,27) is the Oil/Coal Industry delivering to habitat destruction in Lancaster County. According to the World Wildlife Fund, "oil and gas exploration and development causes disruption of migratory pathways, degradation of important animal habitats, and oil spills—which can be devastating to the animals and humans who depend on these ecosystems" (WWF, 2017).

Infrastructure delivering to Social Institutions (19,15) (19,18)

Cells (19,15) and (19,18) are Infrastructure delivering criteria to the Wind Energy Developers and the Oil/Coal Industry. In order to develop wind farms or produce oil and coal for energy purposes, their needs to be adequate and functional infrastructure in Lancaster County. Without a proper electrical grid, functional roads and drainage, and buildings to house the energy produced,

neither wind energy developers or the oil/coal industry could produce their energy products (Wind Energy, 2017).

Technology delivering to the Nebraska Legislature (20,13) (21,13) (22,13) (23,13)

Cells (20,13) (21,13) (22,13) and (23,13) are Maintenance Costs, Transportation Costs, Wind Turbines, and Energy Storage delivering to the Nebraska Legislature. Each of these technologies deliver criteria to the Nebraska Legislature in the form of economic viability. As the costs of wind turbine maintenance and transportation decrease, the Nebraska Legislature is more likely to pass laws and regulations that allow for the development of wind energy.

Technology delivering to the Lancaster County Board (20,16) (21,16) (22,16) (23,16)

Cells (20,16) (21,16) (22,16) and (23,16) are Maintenance Costs, Transportation Costs, Wind Turbines, and Energy Storage delivering to the Lancaster County Board. Similar to the deliveries from technology to the Nebraska Legislature, each of these technologies deliver criteria in the form of economic viability. The Lancaster County Board is also concerned with the costs of these technologies and will be more likely to allow for wind energy development if the cost is decreased.

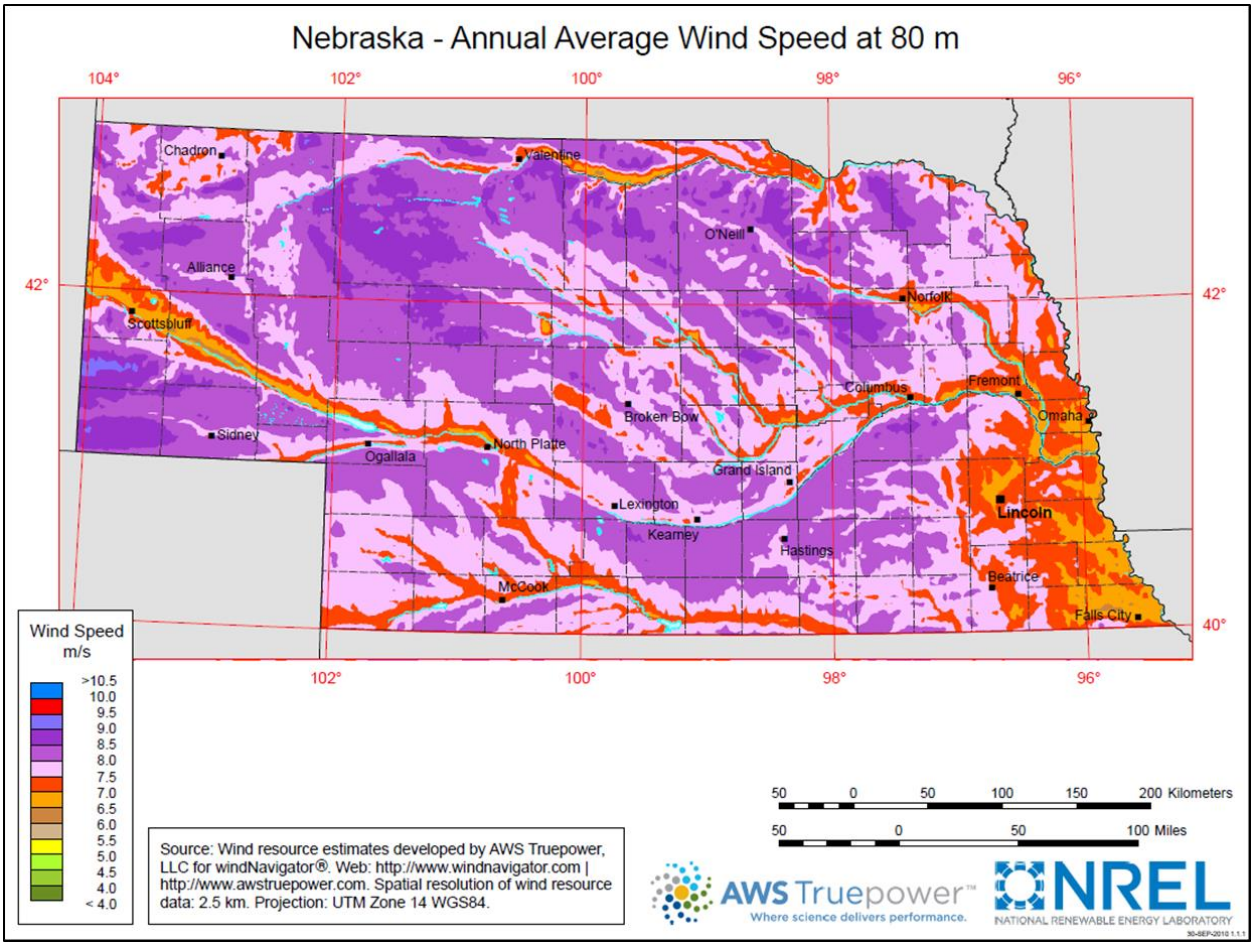
Ecology delivering to the Lower Platte South NRD (25,11) (26,11) (27,11)

Cells (25,11) (26,11) and (27,11) are various ecological systems (land, migrating bird habitat, and habitat destruction) delivering to the LPSNRD. The NRDs of Nebraska and responsible for protecting each of these ecological systems and have programs that work to perverse all of them (Nebraska Association). The conservation easements protect land in Lancaster County (Projects

Completed, 2017). Conservation of surface water environments and management of wildlife habitats protect migrating bird habitats and prevent habitat destruction (Nebraska Association).

Wind Speeds delivering to the Engineers and Wind Energy Developers (24,15)

Cell (24,15) is the wind speeds delivering criteria to the wind energy developers. In order for a wind farm to be profitable and effective, the location the wind farm is in must have adequate wind speeds. According to the Nebraska Wind Energy and Wildlife Project, "Nebraska is ranked fourth in the United States for potential wind power generation" (Nebraska Wind, 2017). This map illustrates the wind speeds in Nebraska.



Source: Nebraska Wind Energy and Wildlife Project. (2017). *Wind Speeds*. Retrieved from https://wind-energy-wildlife.unl.edu/wind-speeds.

Deliveries from the Clean Air Act to Social Institutions (28,15) (28,18)

Cells (28,15) and (28,18) are the Clean Air Act delivering criteria to the wind energy developers and the oil and coal industries of Lancaster County. According to the EPA website, "the Clean Air Act (CAA) is the comprehensive federal law that regulates air emissions from stationary and mobile sources" (EPA, 2017). It does this by establishing National Ambient Air Quality Standards (NAAQS) in every state in the United States. The NAAQS limit the amount of pollutants the coal, natural gas, and petroleum companies can emit every year. By setting these limits, it raises the price of producing coal and oil, creating more incentive for states to turn to renewable energy sources like wind energy.

Deliveries from the Clean Power Plan to Social Institutions (29,15) (29,18)

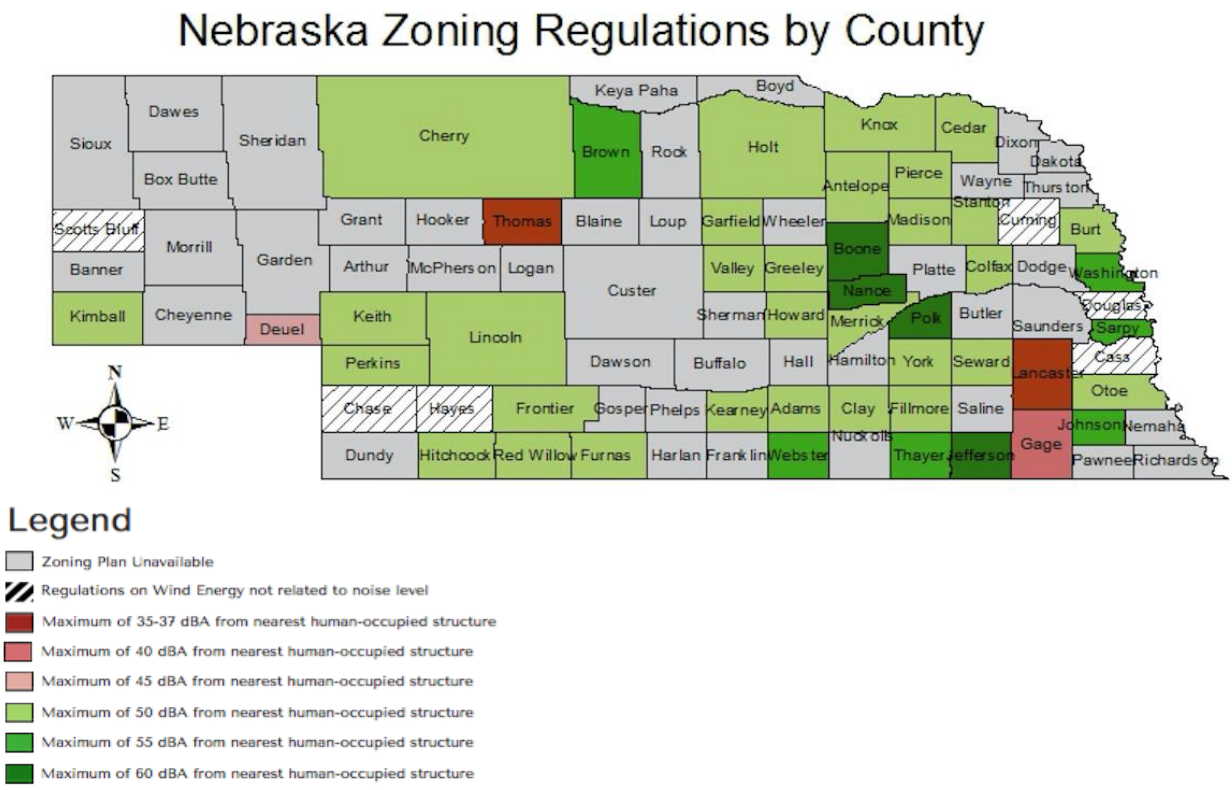
Cells (29,15) and (29,18) are the Clean Power Plan delivering criteria to the wind energy developers and the oil and coal industries of Lancaster County. The Clean Power Plan (CPP) stemmed from the CAA, but is an updated and more strict version. According to the EPA's archive website, the CPP "maintains an affordable, reliable energy system, while cutting pollution and protecting our health and environment now and for future generations" (EPA, 2017). The goal of the CPP is to cut carbon emissions from power plants by 30% by 2030. Much like the CAA, this regulation limits the amount of pollutants the coal and oil companies in Lancaster County can produce and makes it more expensive to produce their products. The CPP is another standard that increases the incentive for states to produce more renewable energy like wind energy.

Other Counties/States delivering to Social Institutions (30,13) (30,16)

Cells (30,13) and (30,16) are other counties in Nebraska and other states in the Midwest delivering criteria to the Nebraska Legislature and Lancaster County Board. According to an article published in the Omaha World Herald, the restrictions passed by the Lancaster County Board are more strict that other counties throughout the Midwest. The article writes “50 decibels is recognized as a standard noise limit by several Nebraska Counties” (Hammel, 2015). Although the limit of 40 decibels was adopted by the Lancaster County Board in 2015, this fact was taken into consideration when making that decision.

Zoning Regulations Across the State

The map below shows the number of counties in the state of Nebraska that have zoning regulations related to wind energy.



Source: Nebraska Wind Energy and Wildlife Project. (2016). *County Zoning*. Retrieved from https://wind-energy-wildlife.unl.edu/county-zoning.

Of the 93 counties in the state of Nebraska, 43 of them do not have any zoning regulations relating to wind turbines or wind energy development. Six counties have zoning regulations related to wind energy, but no regulations that deal with the maximum noise levels of wind turbines. Two counties, Lancaster County and Thomas County, have a maximum decibel level from the nearest human-occupied structure of less than 40 decibels. Thomas County has the most strict regulations at 35 decibels and Lancaster County has the second most strict regulations at 37 decibels from 10:00 PM – 7:00 AM. Gage County's regulation is 40 decibels from the nearest human-occupied structure and Deuel County's regulation is 45 decibels. The overwhelming majority of counties (30) with zoning regulations related to the noise level of commercial-sized wind turbines have adopted a maximum of 50 decibels from the nearest human-occupied structure. Six counties have a maximum of 55 decibels and four counties have a maximum of 60 decibels noise limit. (County Zoning, 2016). Overall, 98% of the counties that have zoning regulations related to the noise level of commercial-sized wind turbines allow for decibels louder than Lancaster County.

As identified above, the Lancaster County Board voted to tighten the restrictions on wind energy development in 2015 after receiving a recommendation to do so from the Lincoln-Lancaster County Health Department. While the reasons for this decision have been mentioned above, the following section will detail a policy proposal for wind energy in Lancaster County based on Elinor Ostrom's *Social-Ecological Systems Framework*.

Policy Proposal/Discussion

The question of whether wind energy should be developed in Lancaster County is complex and contains many actors that play a variety of different parts in policy recommendation and implementation. Throughout this paper, I only touched on the variety of institutions, social beliefs, technological systems, and ecological systems that have contributed to the barriers that have hindered the development of wind energy in Lancaster County, Nebraska. For the sake of simplicity, I did not take into consideration any cultural values or personal attitudes that have contributed to the issue at hand.

After completing research on the various social and political institutions at play in the development of wind energy in the county, I have come to the conclusion that Lancaster County should loosen its noise level regulations on commercial-sized wind turbines from 40 dBA from 7 AM – 10 PM and 37 dBA from 10 PM – 7 AM to 50 dBA from the nearest human occupied structure. Lancaster County is the second most populated county in the state of Nebraska and is home to the state capital, Lincoln. Because of these two factors, Lancaster County holds a great amount of political weight in the state. If the regulations are not loosened to 50 dBA from the nearest human occupied structure, other counties are likely to adopt more restrictive noise regulations in the future. This could prohibit wind energy developers from funding new wind farms in the state; taking away opportunities for economic development from the citizens of both Lancaster County and the state of Nebraska.

According to the *Social-Ecological Systems Framework* introduced by Elinor Ostrom, a system of governance must be put in place to govern natural resources and prevent a "tragedy of the commons" situation from occurring (Ostrom, 2009). As the demand for renewable energy increases, a greater number of counties in Nebraska are going to adopt zoning regulations like

those recommended in the *Social-Ecological Systems Framework*. As this begins occurring, it is important for Lancaster County to serve as another example of a Nebraska county with reasonable noise level restrictions on commercial-sized wind turbines.

This being said, I have also found that Lancaster County is not the most viable location for the development of wind farms. Although the cost of wind energy has been decreasing over the past couple decades and much of the population of Lancaster County support increased amounts of wind energy, there are too many negative variables at play. The population of Lancaster County is too large for a major development of wind energy. Although being the second highest populated county in the state gives Lancaster County heavy political weight, it also makes most of the county too densely populated for commercial-sized wind farms. The ecological factors of Lancaster County must also be taken into consideration. This county serves as a habitat for various bird species, being so close to the Platte River. Lastly, the wind speeds in Lancaster County, and the majority of Eastern Nebraska, are not as optimal for wind farm development as other counties in Central and Western Nebraska (Wind Speeds, 2017). Instead, further research must be completed on other sites in the state of Nebraska that would be better suited to host a major wind farm development project.

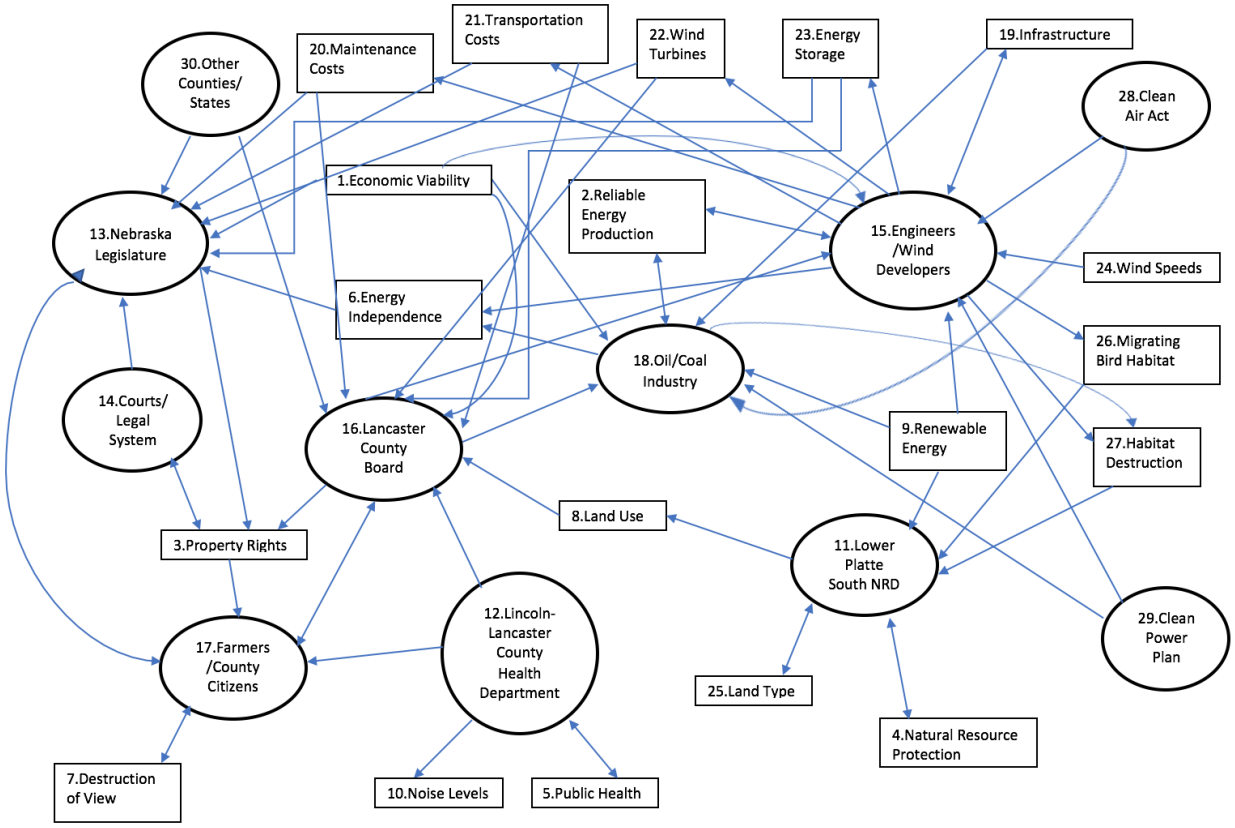
The development of reliable, renewable energy sources in each region in the United States is extremely important in the fight against climate change. Wind energy might not be the most viable or economically feasible option in every state, but it is the best choice for renewable energy in the state of Nebraska. With this being said, it is important to implement policies that will promote and sustain the development of commercial-sized wind energy in our state rather than one that contribute to the barriers already present. Nebraska has the opportunity to become a leader in renewable energy production. This opportunity should not be wasted.

Appendix A

Social Fabric Matrix

Delivering Components			Receiving Components: Social Beliefs										Institutional Organizations							Technology					Ecology				System Environment		
			Economic Viability	Reliable Energy Production	Property Rights	Natural Resource Protection	Public Health	Energy Independence	Destruction of View	Land Use	Renewable Energy	Noise Levels	Lower Platte South NRD	Lincoln-Lancaster County Health Department	NE Legislature	Courts/Legal System	Engineers/Wind Developers	Lancaster County Board	Farmers/County Citizens	Oil/Coal Industry	Infrastructure	Maintenance Costs	Transportation Costs	Wind Turbines	Energy Storage	Wind Speeds	Land Type	Migrating Bird Habitat	Habitat Destruction	Clean Air Act	Clean Power Plan	Other Counties/States
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Social Beliefs	Economic Viability	1													1		1	1		1											
	Reliable Energy Production	2															1			1											
	Property Rights	3														1			1												
	Natural Resource Protection	4											1																		
	Public Health	5												1																	
	Energy Independence	6													1																
	Destruction of View	7																	1												
	Land Use	8																1													
	Renewable Energy	9											1				1		1												
	Noise Levels	10												1																	
Institutional Organizations	Lower Platte South NRD	11				1				1																	1				
	Lincoln-Lancaster County Health Department	12					1											1	1												
	NE Legislature	13			1														1												
	Courts/Legal System	14			1										1																
	Engineers/Wind Developers	15		1				1													1	1	1	1	1			1	1			
	Lancaster County Board	16			1												1		1												
	Farmers/County Citizens	17							1						1			1													
	Oil/Coal Industry	18																										1			
Technology	Infrastructure	19															1			1											
	Maintenance Costs	20													1			1													
	Transportation Costs	21													1			1													
	Wind Turbines	22													1			1													
	Energy Storage	23													1			1													
Ecology	Wind Speeds	24															1														
	Land Type	25											1																		
	Migrating Bird Habitat	26											1																		
	Habitat Destruction	27											1																		
System Environment	Clean Air Act	28															1			1											
	Clean Power Plan	29															1			1											
	Other Counties/States	30													1			1													

Social Fabric Matrix Diagram



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